An Overview of Boron Fertility in Prairie Soils and Canola Response to Fertilization.

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Justification

- Boron (B) is rather unique as only slight changes in B concentration in soil solution are associated with yield impeding deficiency or toxic effects in plants

- Need to consider how soil, crop and management factors affect soil B status and likelihood of response to added B fertilizer.

(Havlin et al., 1999)

Justification

Boron deficiency issues in prairies:

❖ ***Site specific:***

a patchy distribution

-spatial variability of soil properties

(Raza et al., 2002. Karamanos et al., 2003)

Justification

Boron deficiency issues in prairies:

- ***Crop specific:***
  - Canola identified as most susceptible small grain crop

Justification

- Inconsistent yield response to fertilization reported
  - *Uncertainty about soil test critical levels*

- Soil properties may control fate and efficacy
  - *Transformation and complexation*
  - *Redistribution to unavailable pools*

(Karamanos and Goh. 2001, Karamanos et al., 2003)

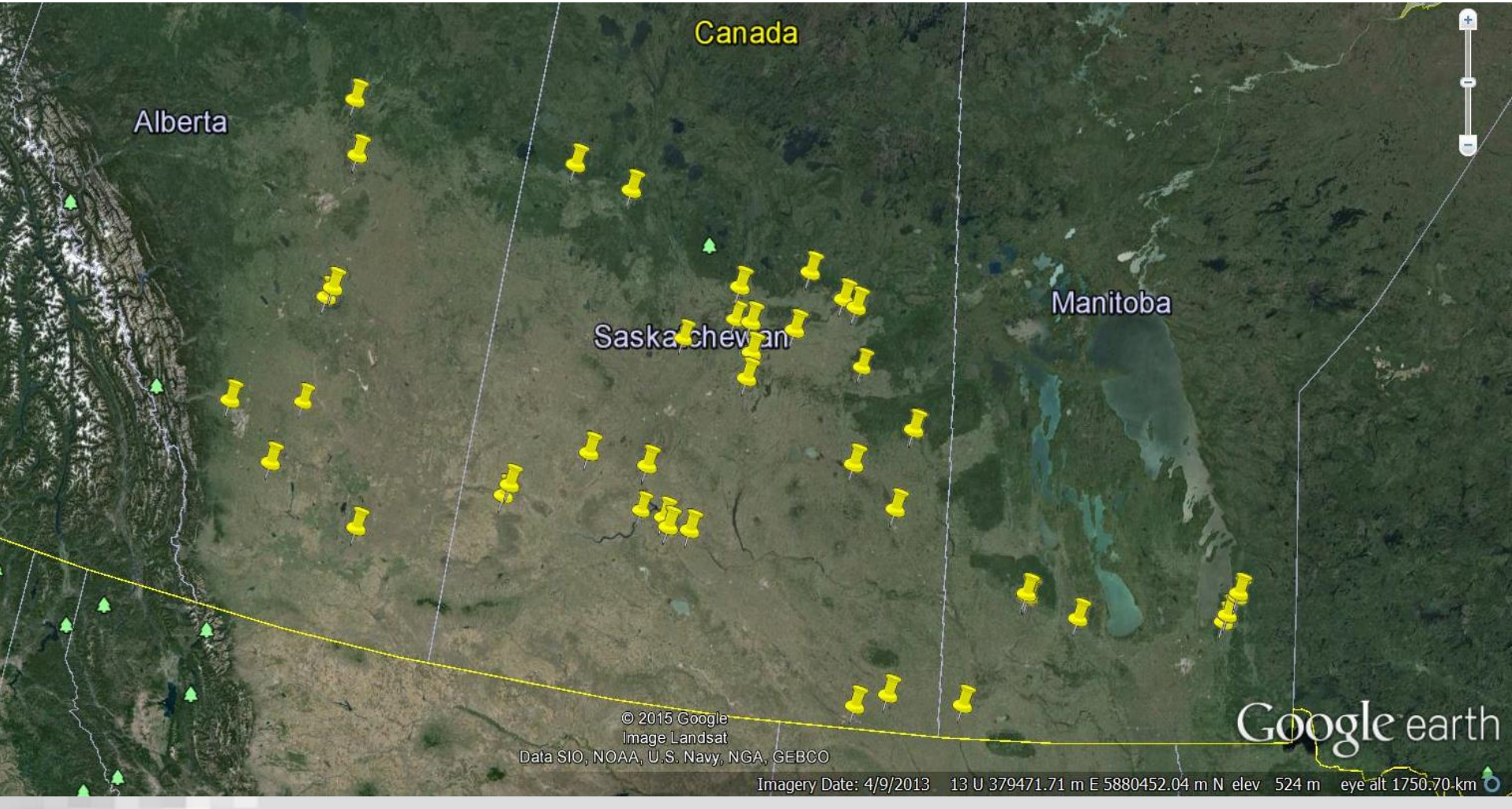
Research questions?

- Which soil properties are contributing to deficiency?
- What is the response of canola to B fertilization?

Objectives

- ✓ To determine available B in prairie soils, and relationship with soil properties
- ✓ To evaluate the impact of B fertilization on yield of canola varieties grown in contrasting prairie soils

Soil Collection



Methods and Materials

- Collection of 47 field soils to represent range of prairie soils with contrasting soil properties:

  Sand: 6% to 94% pH: 5.0 to 7.8, OC: 0.9% to 43%

- Assessment of soil extractable and supply rate of B and relationship to soil properties
  - *hot water extraction for available B, and PRS resin membrane extraction for supply rate*
  - *Hot water B: 0.4 to 3.6 mg B kg^{-1}*

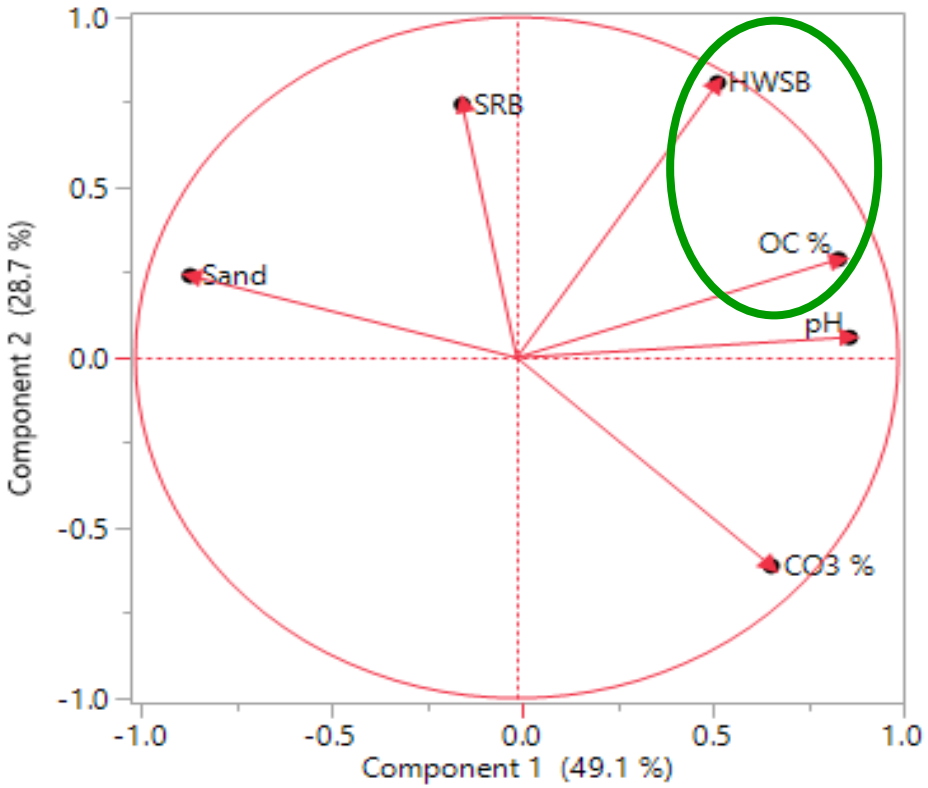
    PRS B supply rate: 0.02 to 0.3 ug/10 cm^2/24hr

- Response of canola to B fertilization in selected soils

Results

Brown soil zone (7 soils)

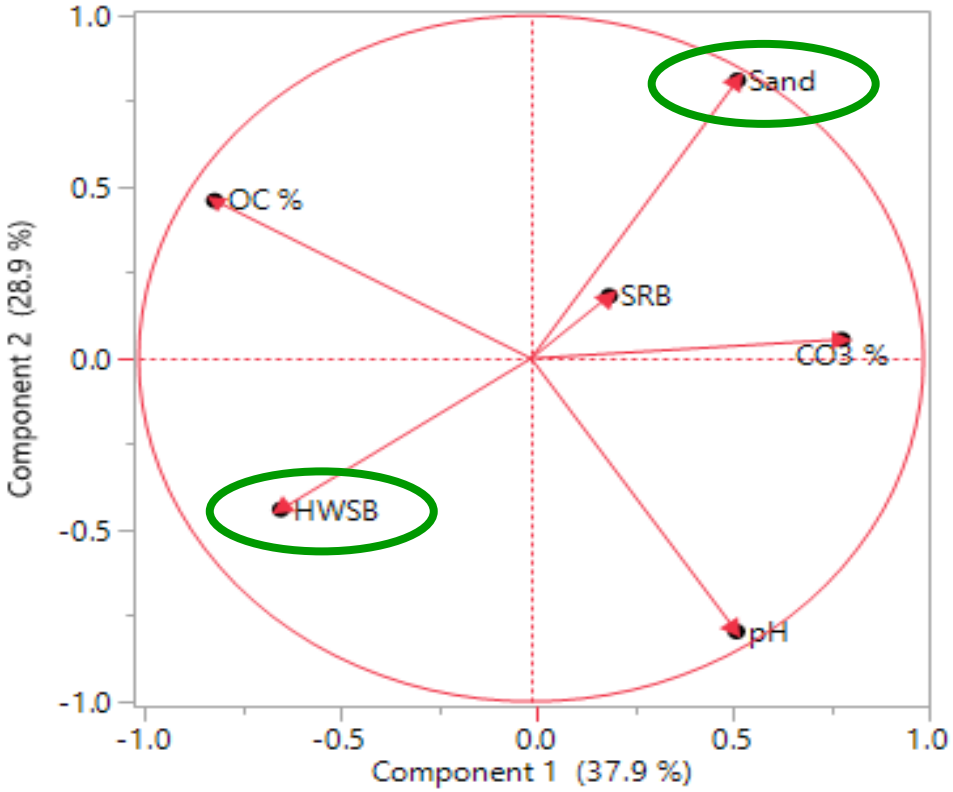
HWSB = Hot Water Soluble B; SRB= Supply Rate of B



Organic C and extractable B most closely related

Dark Brown soil zone (7 soils)

HWSB = Hot Water Soluble B; SRB= Supply Rate of B

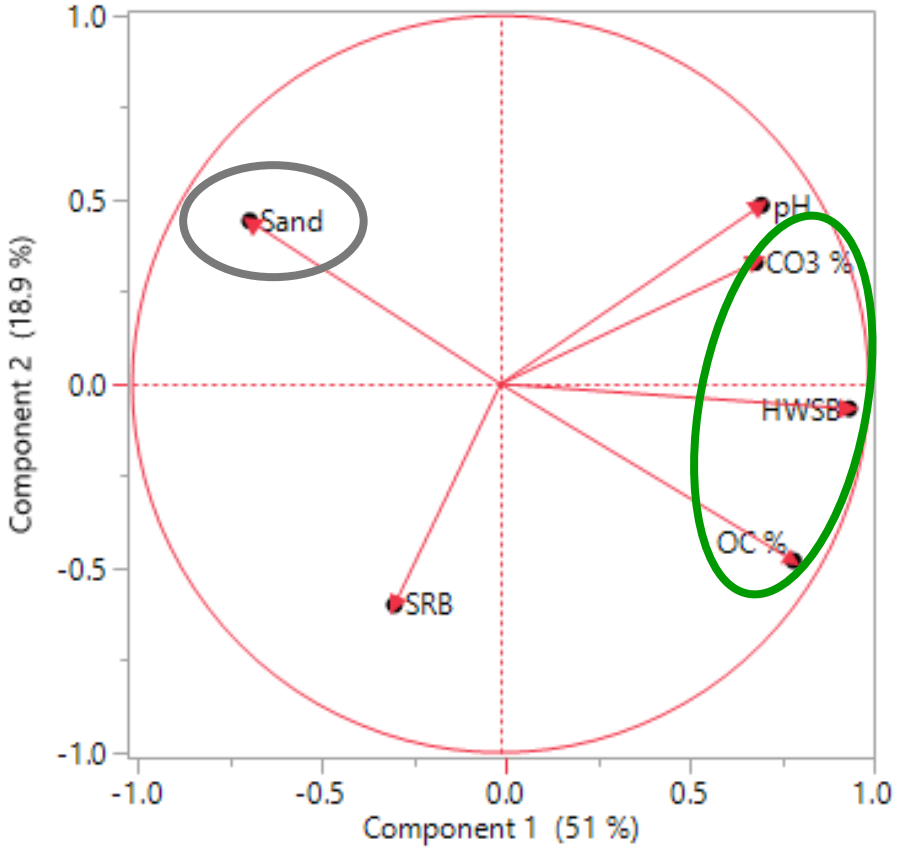


Sand content negatively related to extractable B

High sand content contributes to high supply rate of B

Black soil zone (22 soils)

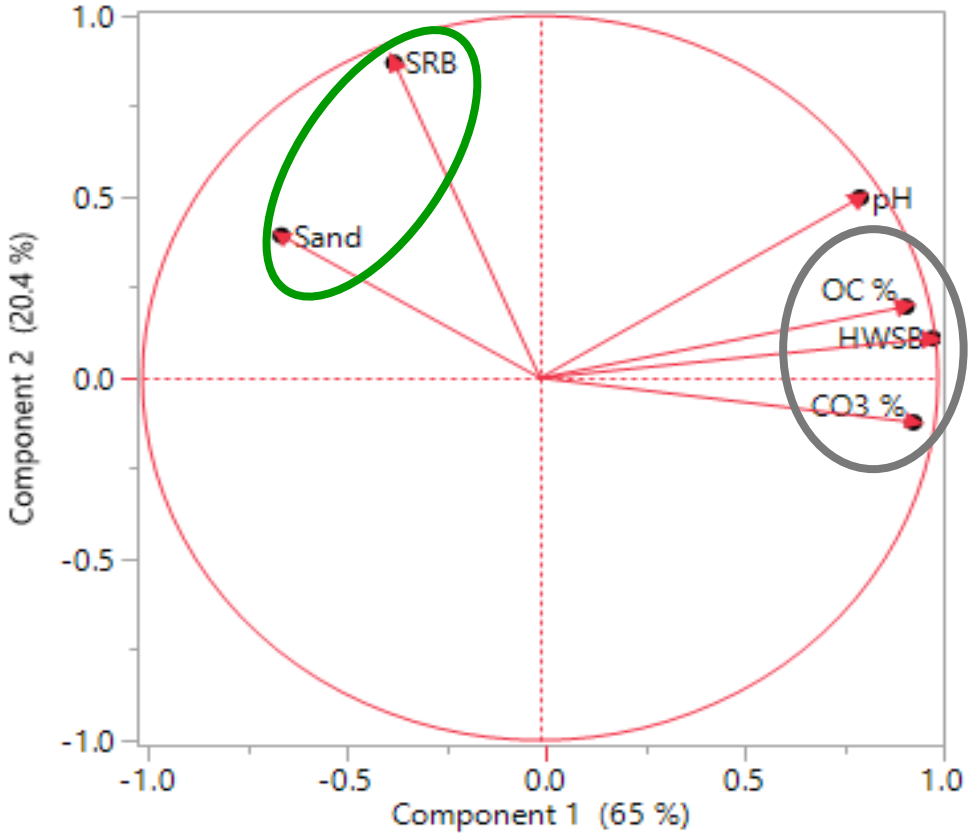
HWSB = Hot Water Soluble B; SRB= Supply Rate of B



Extractable B most positively related to organic C

Gray soil zone (7 soils)

HWSB = Hot Water Soluble B; SRB= Supply Rate of B

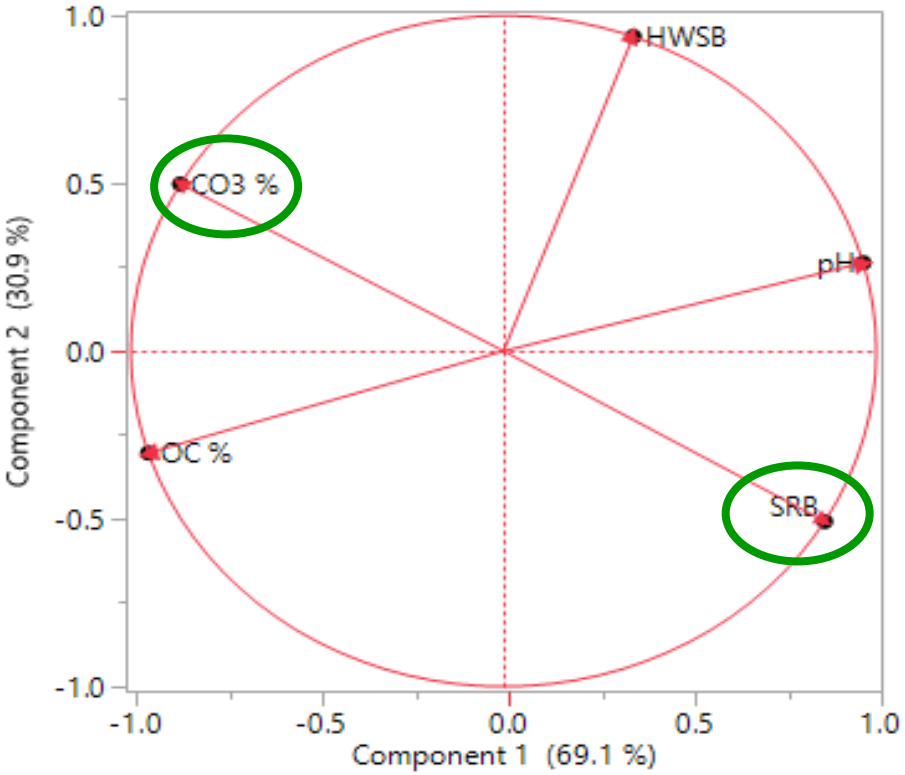


Organic C strong controller of extractable B

Sand contributes to higher supply rate of B

Peat soils (3 soils)

HWSB = Hot Water Soluble B; SRB= Supply Rate of B



Most properties of the peat soil had no relation to available B (only 3 soils); High carbonate = low supply rate of B

Summary

- ✓ **Organic C** strongly contributes to extractable B.
- ✓ **Sand content** is inversely related to extractable B, but directly related to supply rate of B (diffusion).
- ✓ In **peaty soils**, high carbonate content may contribute to low B supply rate.

Canola Response to Boron Fertilization

Soil Factor Evaluation:
Five Contrasting Soils

Whitewood Dark Gray Chernozem (Danbury)
Echo Brown Solodized Solonetz (Central Butte)
Whitefox Dark Gray Chernozem (Nipawin)
Sceptre Orthic Vertisol (Sceptre)
Ukalta Black Chernozem (Alix, AB)

All soils received basal application of N, P, K and S

Methods and Materials

Treatments

T_1: Control

T_2: Soil application @ 1 kg B ha^{-1}

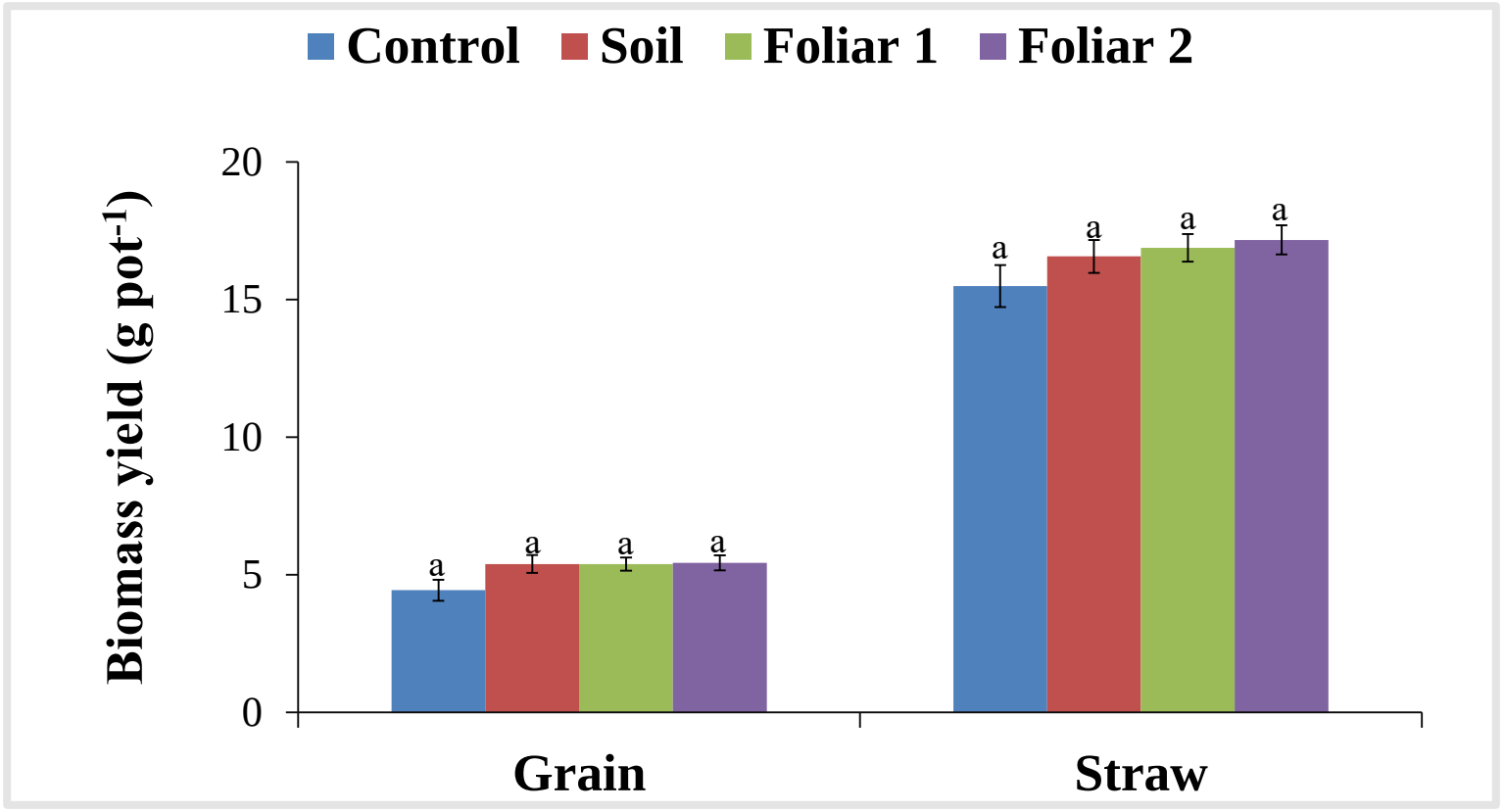
T_3: Foliar application 1 (one time) @ 0.25 kg B ha^{-1}

T_4: Foliar application 2 (two times) @ 0.25 kg B ha^{-1}

Results

WHITEWOOD O.DGC (Danbury, SK)

B= 0.9 mg kg^{-1}; pH=6.9; Sand=49%; OC=3.0%

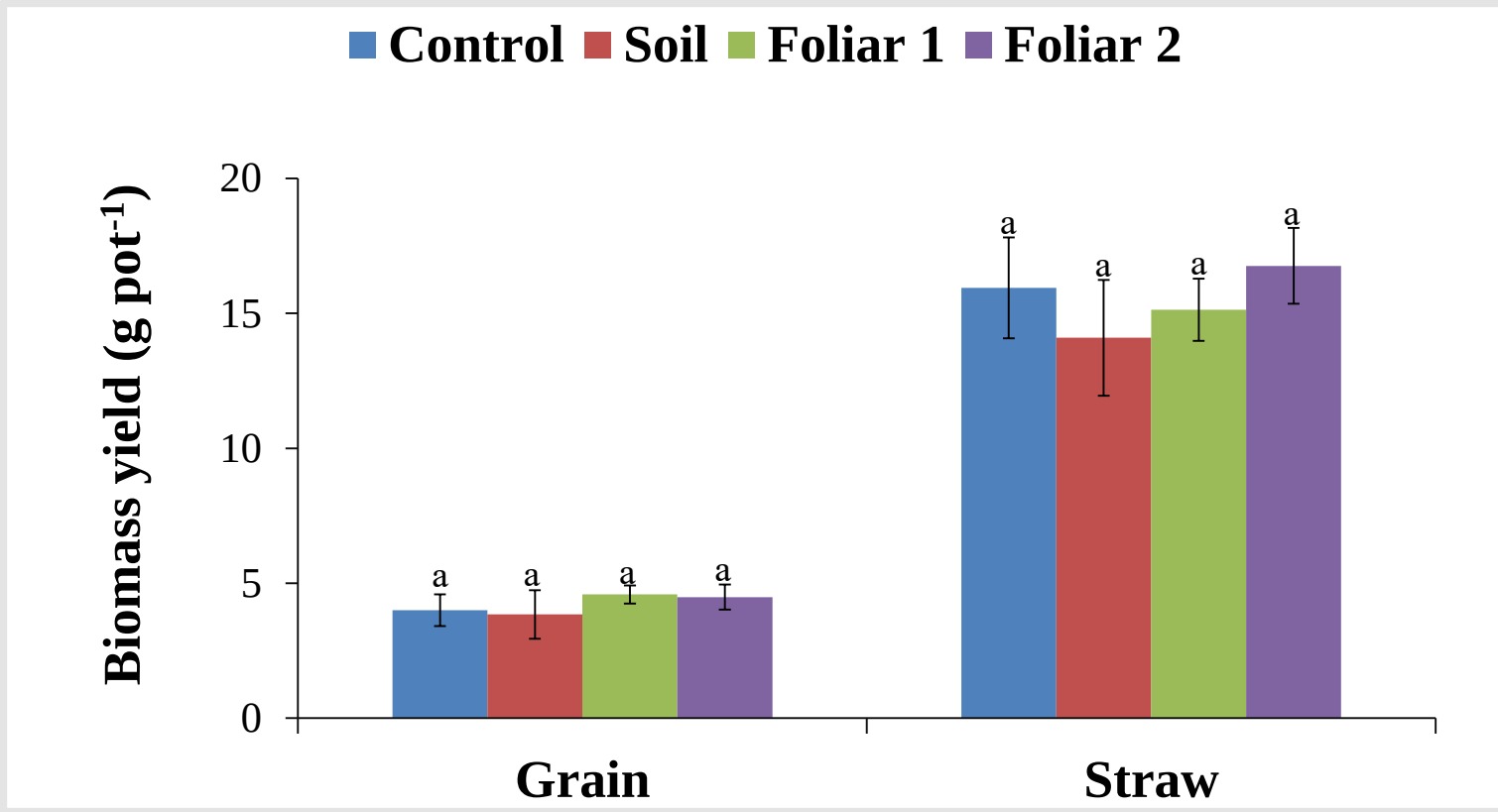


WHITEWOOD O.DGC (Danbury, SK)

B= 0.9 mg kg^{-1}; pH=6.9; Sand=49%; OC=3.0%

Control	Soil	Foliar 1	Foliar 2

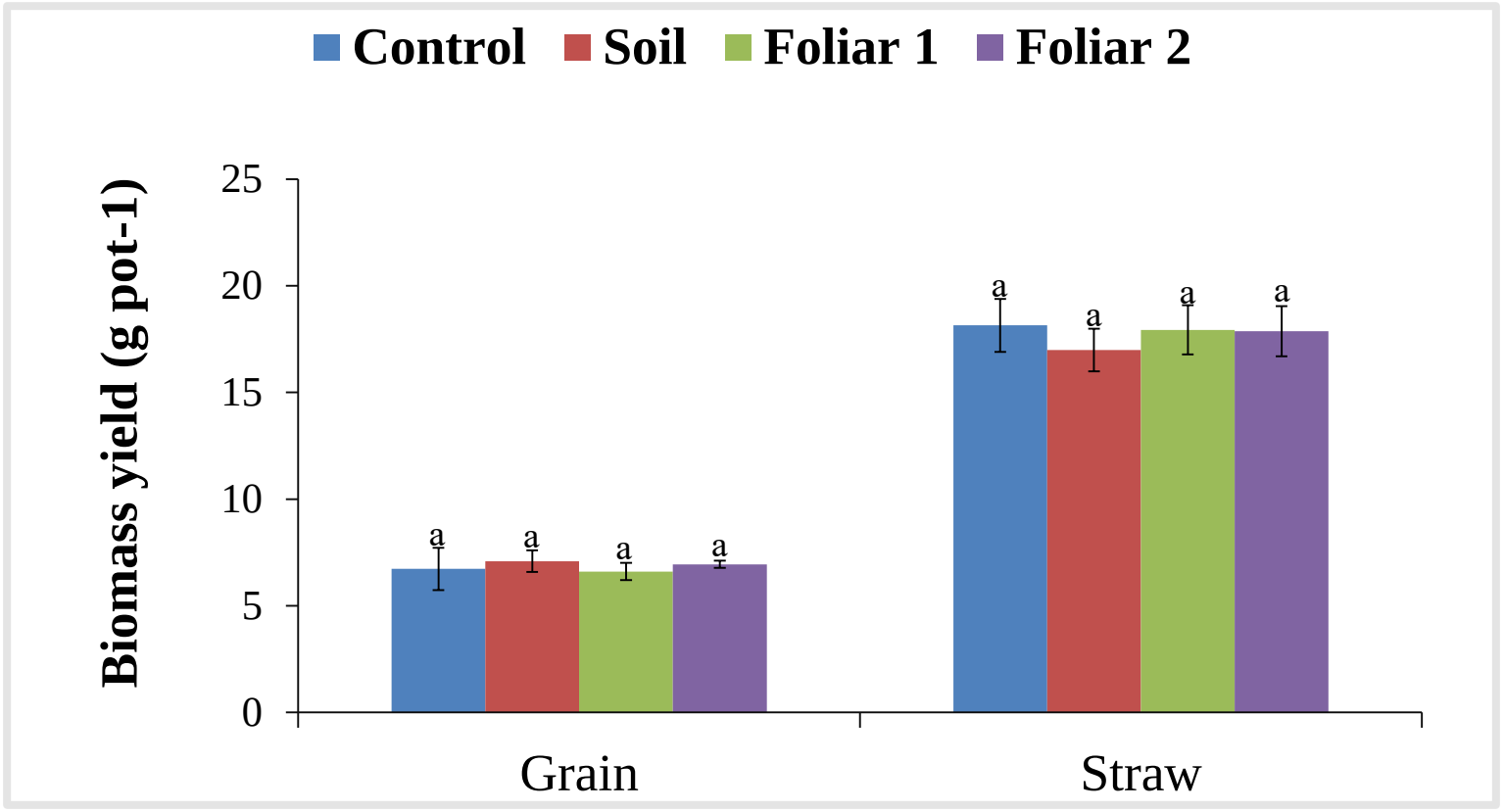
ECHO B.SS (Central Butte, SK):
B= 1.5 mg kg^{-1}; pH=6.5; Sand=44%; OC=2.0%



ECHO B.SS (Central Butte, SK):
B= 1.5 mg kg^{-1}; pH=6.5; Sand=44%; OC=2.0%

Control	Soil	Foliar 1	Foliar 2

UKALTA series (Alix, AB)
B= 0.9 mg kg^{-1}; pH=5.5; Sand=81%; OC=2.6%

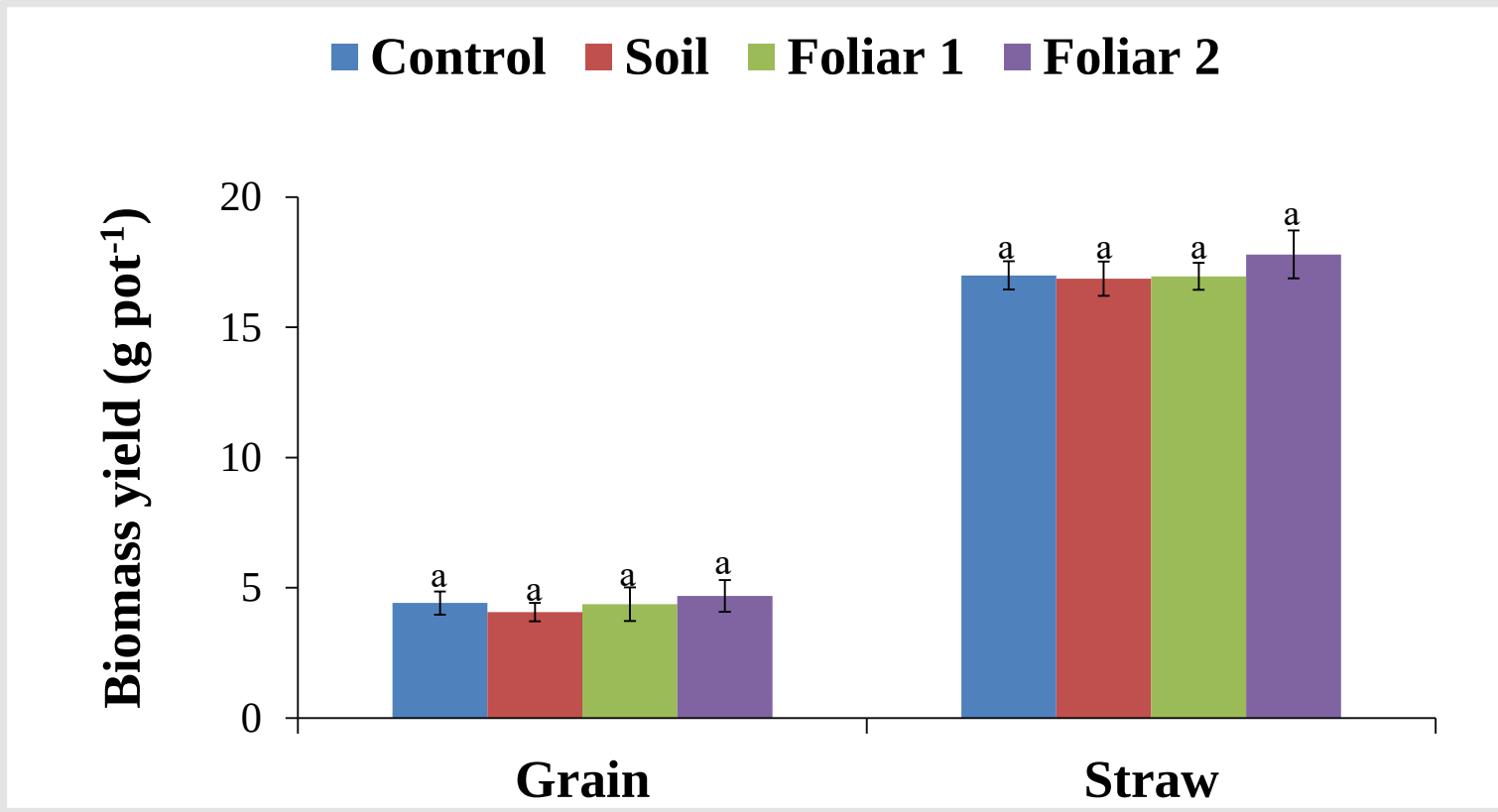


UKALTA series (Alix, AB)

B= 0.9 mg kg^{-1}; pH=5.5; Sand=81%; OC=2.6%

Control Soil Foliar 1 Foliar 2

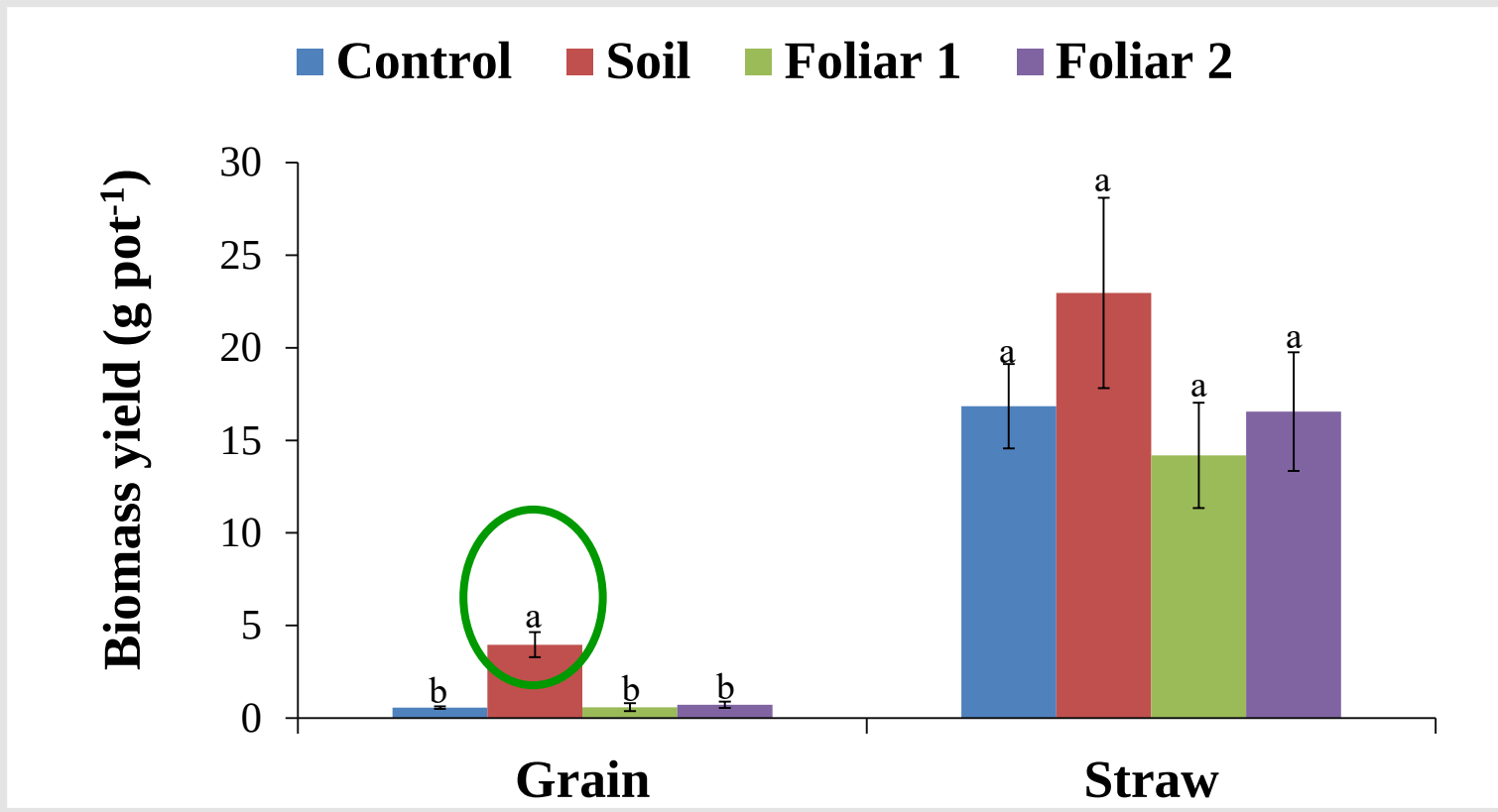
SCEPTRE O.V (Sceptre, SK)
B= 1.1 mg kg^{-1}; pH=7.6; Sand=7%; OC=1.7%



SCEPTRE O.V (Sceptre, SK)
B= 1.1 mg kg^{-1}; pH=7.6; Sand 7%; OC=1.7%

Control	Soil	Foliar 1	Foliar 2

WHITEFOX O.DGC (Nipawin, SK)
B= 0.45 mg kg^{-1}; pH=5.0; Sand=57%; OC=2.2%



WHITEFOX O.DGC (Nipawin, SK)
B= 0.45 mg kg^{-1}; pH=5.0; Sand=57%; OC=2.2%

Control | Soil | Foliar 1 | Foliar 2

WHITEFOX O.DGC (Nipawin, SK)

B= 0.45 mg kg^{-1}; pH=5.0; Sand=57%; OC=2.2%

Control | Soil | Foliar 1 | Foliar 2

Summary

- Of the five soils, canola responded to B on one soil (Whitefox)
  - ✓ extractable B was at marginal level (HWSB = 0.45 mg kg^{-1})
  - ✓ only soil application was effective.

Crop Factor:
Genotype evaluation

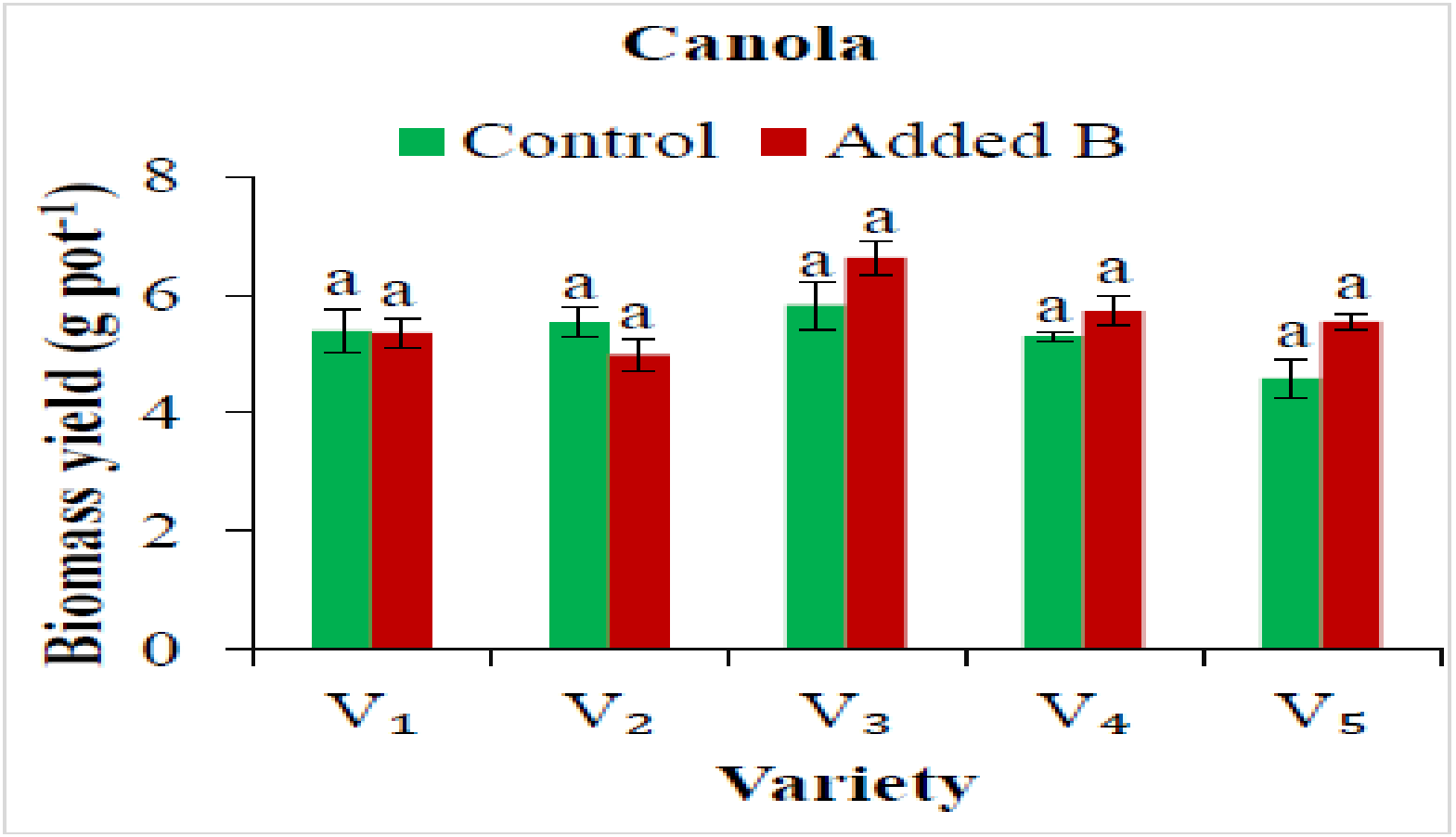
- ***Control*** versus ***B fertilization*** treatments were tested on ***five different varieties/market classes*** of canola on low extractable B soil (Meota)

Canola varieties (genotypes)
V_1: InVigor LL 252 (*B. napus)*
V_2: Roundup Ready VT 500G *(B. napus)*
V_3: Andante mustard (Yellow; *Sinapsis Alba*)
V_4: XCEED 8571 (*B. juncea*)
V_5: ACS-C7 (Polish; *B. rapa*)

Results

Meota O.BLC:

B=0.6 mg kg^{-1}; pH=6.7; Sand=89%; OC=1.7%



Summary

- No significant yield response of any canola varieties to B fertilization on low extractable B Meota soil.

- High supply rate (0.12 ug/10 cm^2/24hr) detected in this soil (coarse texture).

Take Home Message

- In mineral soils, **organic matter has strongest relationship** with soil test extractable B. Texture and pH had more variable influence. Soil B chemistry is complex!

- Yield response to boron fertilization may be expected in soils with HWSB value at critical level (<0.35 mg B kg^{-1}). Taking into consideration effects of soil properties on **ability of B to move** in soil also seems important.

Next Steps

- To understand bioavailability and fate of applied B in relation to soil properties, rhizosphere modification and plant uptake

✓ *Chemical and Spectroscopic Speciation!*

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Thank you

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